Dirisolar airships

Peter Lobner, 28 July 2019

Background

Dirisolar was founded in 2009 by Philippe Tixier, the inventor of the flat-bottom airship, with the goal of developing relatively small, solar-powered airships for a range of applications, including very long-duration remote sensing, scientific exploration, and tourism. An objective is to be able to make the first airship able to go around the world without refueling and with a freedom in the journey choice.

In 2012, Dirisolar signed six cooperation agreements with European firms for construction of the DS 1500 five-passenger, solar-powered airship. These firms are specialists in the following areas:

- Virtual prototyping
- Construction of electric motors and low noise propellers
- Fabrication of sails
- Manufacture of helium bags
- Solar collector system design

In December 2017, the new company Dirisolar SAS took over all the assets of the company Dirisolar and of the company Air Azur, which was founded in 2013 to be an operator of Dirisolar airships.

The Dirisolar website is here: http://dirisolar.com/Projets/en/

A short video, “DIRISOLAR volez comme vous voulez / fly easy, fly forever,” describes the Dirisolar airship in French with English subtitles. You’ll find this video here: https://www.youtube.com/watch?v=rKFSfHUdzmk

A longer video, “Dirisolar DS 1500: Un dirigeable très innovant” (Dirisolar DS 1500: A very innovative rigid airship) in French and with more animation to illustrate the operation of the airship is available here: https://www.youtube.com/watch?v=l0Hz56oWf-M

General characteristics of Dirisolar airships

The key features and innovations in Dirisolar airships are summarized below.

- **Flat bottom with rigid aeroshell:** The shape of the envelope is asymmetrical. The top is curved while the bottom is almost a flat surface, with the traditional protruding gondola being replaced with a crew / passenger cabin located at the front of the airship. This asymmetry The benefits of the flat-bottomed airship are: (1) it improves airship handling in the wind close to the ground, enabling the airship to settle on the ground instead of being lifting by the wind, (2) the loading and unloading of passengers and cargo is easier than from a conventional gondola, and (3) it is easier to anchor / moor the airship for extended parking on the ground. The flat-bottom airship design concept and associated landing and mooring methods have been patented and recognized both in France (Official Title FR2978120 B1) and in the United States (US Patent 9 415 852 B2).

- **Hybrid lift:** With aerostatic lift alone, the airship is trimmed to be slightly heavier-than-air. This improves airship handling in the wind close to the ground. When the airship is in forward flight, it flies nose-up to generate aerodynamic lift. Vectored thrust from propellers provides the balance of lift when required.

- **Vectored thrust for control near the ground:** Vectored thrust from “levitation” propellers provides the necessary fine lift control to deal with the effects of the wind near the ground.

- **Variable buoyancy:** Aerostatic lift can be changed by compressing a portion of the helium lift gas in the gas envelope and storing it temporarily in onboard pressurized tanks. On landing, this is done to make the airship significantly heavier than air to improve stability on the ground. In preparation for takeoff, the pressurized helium tanks are vented into the lift gas envelope to restore the aerostatic lift needed for flight.

- **Unique steering system:** Front canards steer the airship and improve maneuverability. Rear “feathers” stabilize oscillations in flight and support the airship on the ground.

- **Able to operate in strong winds:** Coupled with the greater near-ground stability derived from the flat-bottomed aeroshell and hybrid lift, vectored thrust enables the airship to operating in winds up to 80 kph (50 mph) without a team on the ground.

- **High operational availability:** The goal is 90%, which is much higher than typical airship availability. The ability to operate in moderate to heavy winds significantly reduces the impact of weather on airship flight operations.

- **Solar powered, no carbon dioxide emissions:** The airship operates entirely on solar power, with an onboard electrical system supplying all propulsion and other airship systems and an energy storage system with ultralight batteries that can be scaled to support long-duration missions. Operation of the airship generates no carbon dioxide emissions.

- **Low noise:** Modest-sized, all-electric Dirisolar airships are very quiet and should be able to operate in areas with noise restrictions that would block the use of engine-driven airships.

- **Minimum ground handling requirements:** A Dirisolar airship lands on the ground and is able to secure itself with systems on the airship and only modest effort by the crew. No other ground support staff are required.

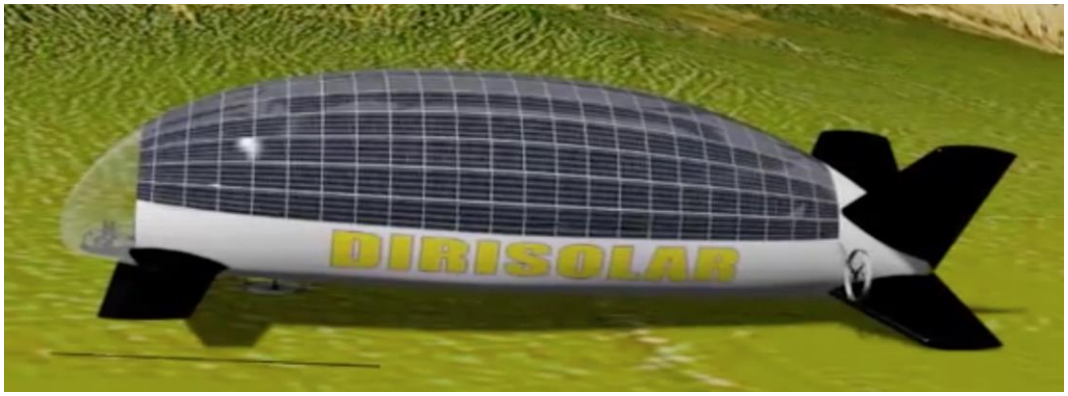
- **Novel (and patented) anchoring device and landing and mooring method:** The unique devices and methods are covered by patents: France (Official Title FR2978120 B1) and in the United States (US Patent 9 415 852 B2).

- **Very low operating cost:** With no fuel costs, a small crew, and minimal requirements for an operating base, a Dirisolar airship should have operating costs much lower than competing alternatives, such as small fixed-wing aircraft.

Landing, anchoring and mooring a Dirisolar airship

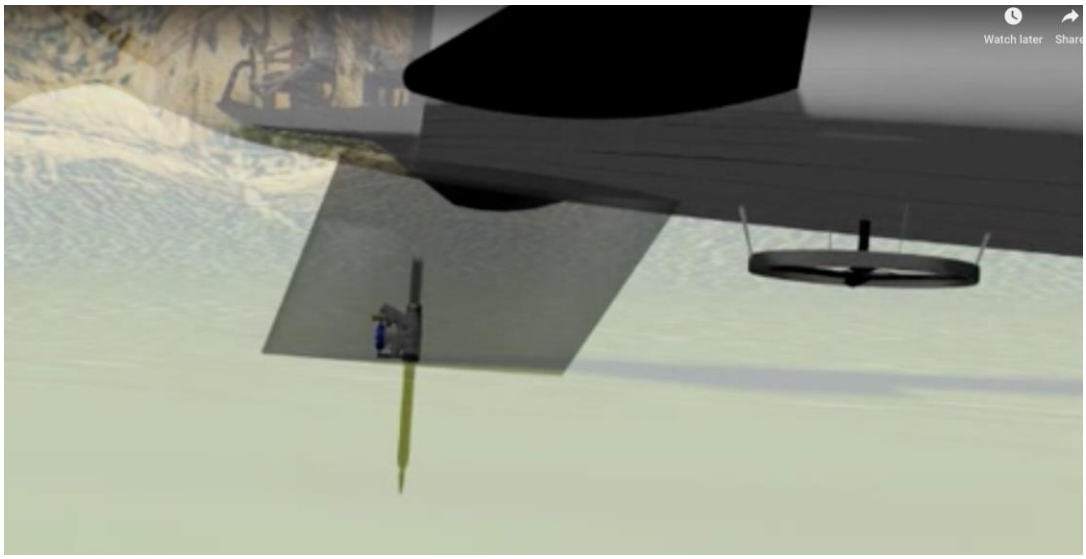
The two graphics below show a DS 900 Dirisolar airship landing in a nose-up attitude, which enables it touch down on the tail and then settle quickly to the ground.

Dirisolar airship approach and landing.
Source: screenshots from Dirisolar video



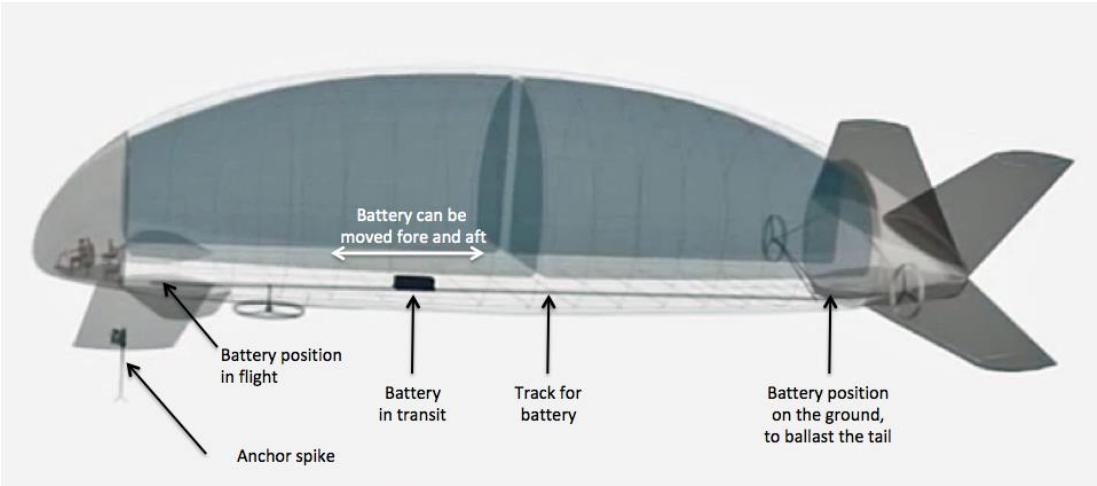
The following graphics show the post-landing sequence of events that will secure the airship on the ground:

- An anchor in the nose fin penetrates the ground to hold the nose down and serve as a pivot point
- Wheels attached to the tail control surfaces after landing allow the airship to be pointed into the wind, and
- The battery is moved from a position near the nose of the airship to the tail where it serves as ballast to prevent wind gusts from lifting the tail.



An anchor in the nose fin penetrates the ground after landing.
Source: screenshot from Dirisolar video

Wheels attached to the rear stabilizers after landing.
Source: screenshot from Dirisolar video



DS 900 airship internal arrangement shows the movable battery.
Source: adapted from a screenshot from a Dirisolar video

DS 0.6 sub-scale concept demonstrator

The DS 0.6 sub-scale demonstrator was built by Pierre Yves Duchesne in 2010 with the goal of validating the advantages of a flat-bottomed airship. Basic characteristics of the DS 0.6 are as follows:

- Length: 2 meters (6.6 feet)
- Helium volume: 1.2 cubic meters (49.4 cubic feet)
- Flight speed: maximum 15 kph (9.3 mph)

Indoors flight tests were conducted at Mantes, France in June 2010. The DS 0.6 also participated in a 2011 indoor competition for radio-controlled airships in Meudon. Dirisolar received the Innovation Award at the Paris Air Show in June 2011 for the DS 0.6, presented by France's Minister of Transport.

DS 0.6 in flight. Source: Dirisolar

See a short video of an indoor test flight of the DS 0.6 here: https://www.youtube.com/watch?time_continue=72&v=kjHUSpFW77Q

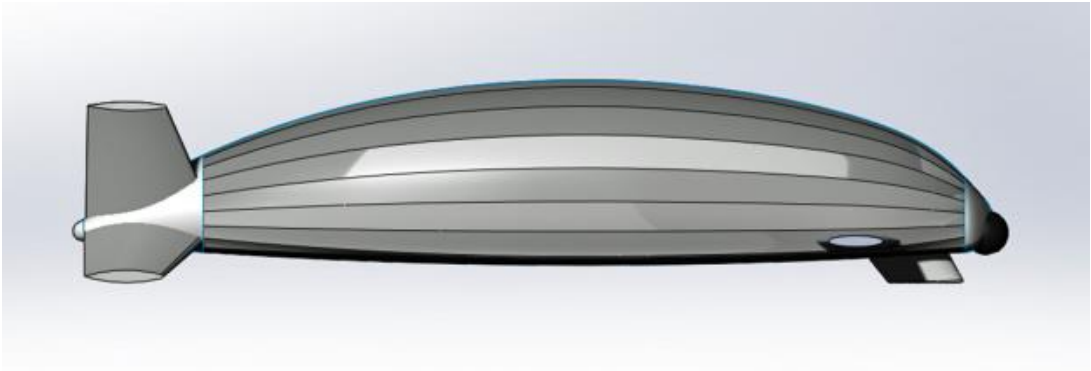
DS 12

The DS 12 is a small, remotely-operated drone airship intended for long-duration surveillance and monitoring missions. The small payload can accommodate video or other remote sensing systems and associated equipment for communication to a home base.

Rendering of DS 12 in flight. Source: Dirisolar

Basic characteristics of the DS 12 are as follows:

- Length : 8 meters (26.3 feet)
- Helium volume : 12 cubic meters (1,424 cubic feet)
- Payload: 1.5 kg (3.3 lb)
- Flight speed: maximum 45 kph (28 mph)
- Mission endurance: days



DS 12 profile view. Source: Dirisolar

DS 900

The DS 900 was a design for a small, two-place airship that met the French definition for an Ultra Light Motorized (ULM) Class 5 airship / aerostat. The DS 900 was intended for applications in scientific exploration and tourism.

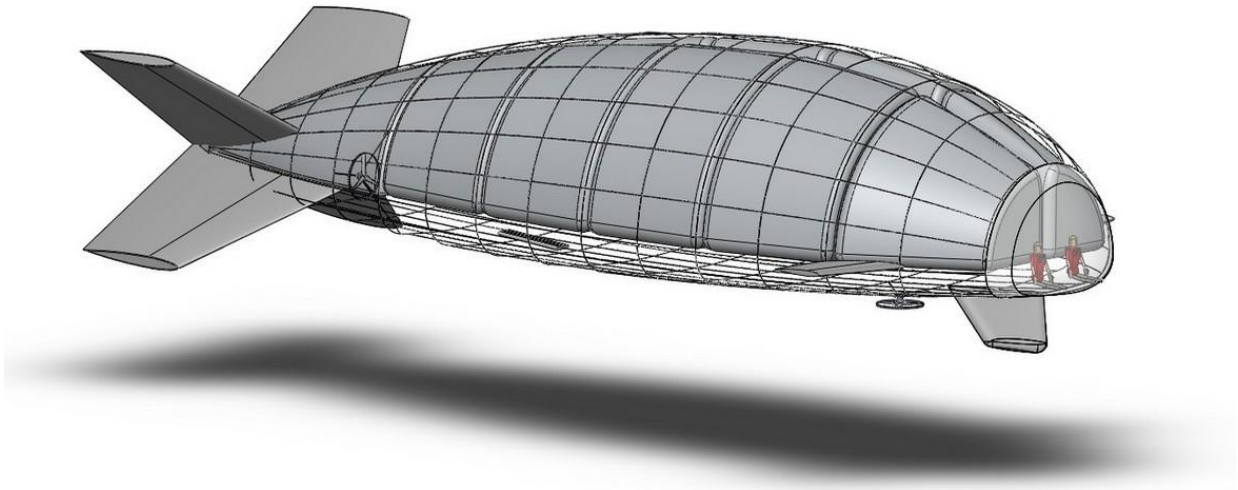
Basic characteristics of the DS 900 were as follows:

- Length: 30 meters (98 feet)
- Helium volume: 900 cubic meters (31,783 cubic feet)
- Payload: 150 kg (331 lb), for example two persons (pilot & passenger)
- Propulsion: 3 electric motor-driven propellers; 2 for propulsion and 1 for “levitation”

The preliminary studies of the full-size DS 900 design, which included modeling and analysis using computer-aided optimization (CAO) and computational fluid dynamics (CFD) software, were validated in 2011 during a formal design review. However, DS 900 development was suspended when it was determined that the larger DS 1500 would be a better match to customer needs in the intended markets.

Rendering of a DS 900 in flight. Source: Dirisolar

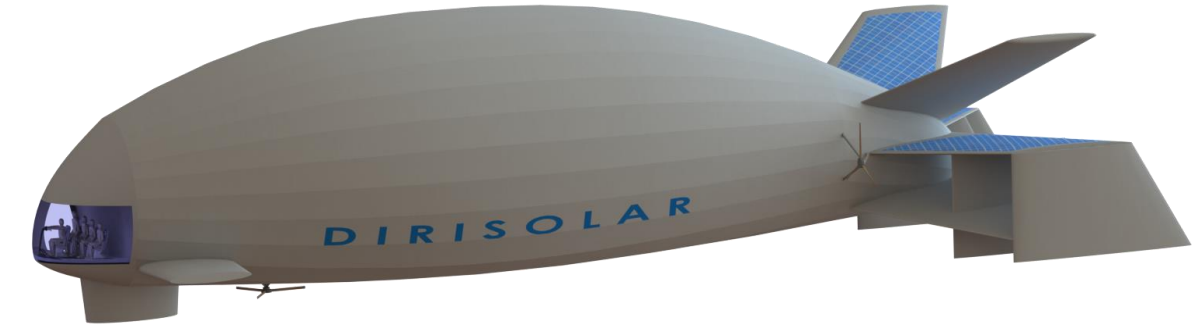
Rendering of a DS showing the solar panels.
Source: screenshot from Dirisolar video



Structural arrangement of the DS 900. Source: Dirisolar

DS 1500

After establishing its industrial team, Dirisolar formally launched the project to develop the larger, five passenger DS 1500 in 2013. In 2014, Dirisolar formed a partnership with ESI Group to use their Virtual Performance Simulation (VPS) software for DS 1500 virtual prototyping and optimization.



Renderings of the DS 1500.
Source: Dirisolar

Basic characteristics of the DS 1500 are as follows:

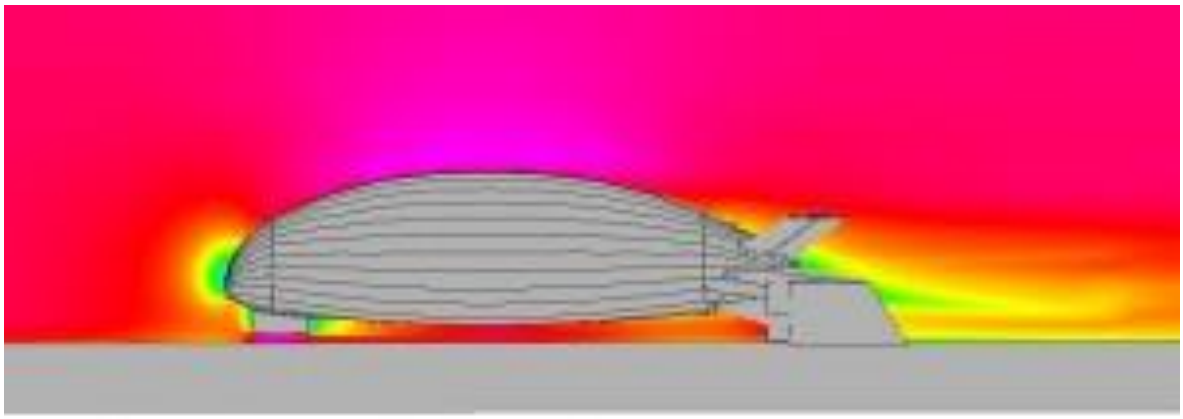
- Length: 50 m (164 feet)
- Helium volume: 1,800 cubic meters (63,566 cubic feet)
- Flight speed: maximum 50 kph (31 mph)
- Payload: 450 kg (992 lb), for example five persons (pilot and four passengers) and small personal equipment
- Propulsion: 3 electric motor-driven propellers; 2 for propulsion and 1 for “levitation”

The short-term commercial objective of this project is the commissioning of one or more DS 1500 airships at Mont Saint Michel, France to conduct regular tourist flights in the vicinity. With high operational availability, Dirisolar expects that a DS 1500 can fly 10,000 passengers per year.

Rendering of a DS 1500 in flight at Mont Saint Michel.
Source: Dirisolar

Under the EU’s Horizon 2020 program for funding research and innovation, Dirisolar proposed in 2016 to develop a drone version of the DS 1500 for agricultural aerial surveillance, with the goal of locating diseases and pests more efficiently than by methods currently used by that industry. Extremely long mission durations are possible with the solar-powered DS 1500 drone.

Rendering of a DS 1500 in flight. Source: Dirisolar



Visualization of airflow around the hull of a DS 1500 on the ground. Source: Dirisolar.

Beyond the DS 1500

Dirisolar claims that the DS 1500 design can be scaled up for larger airships.